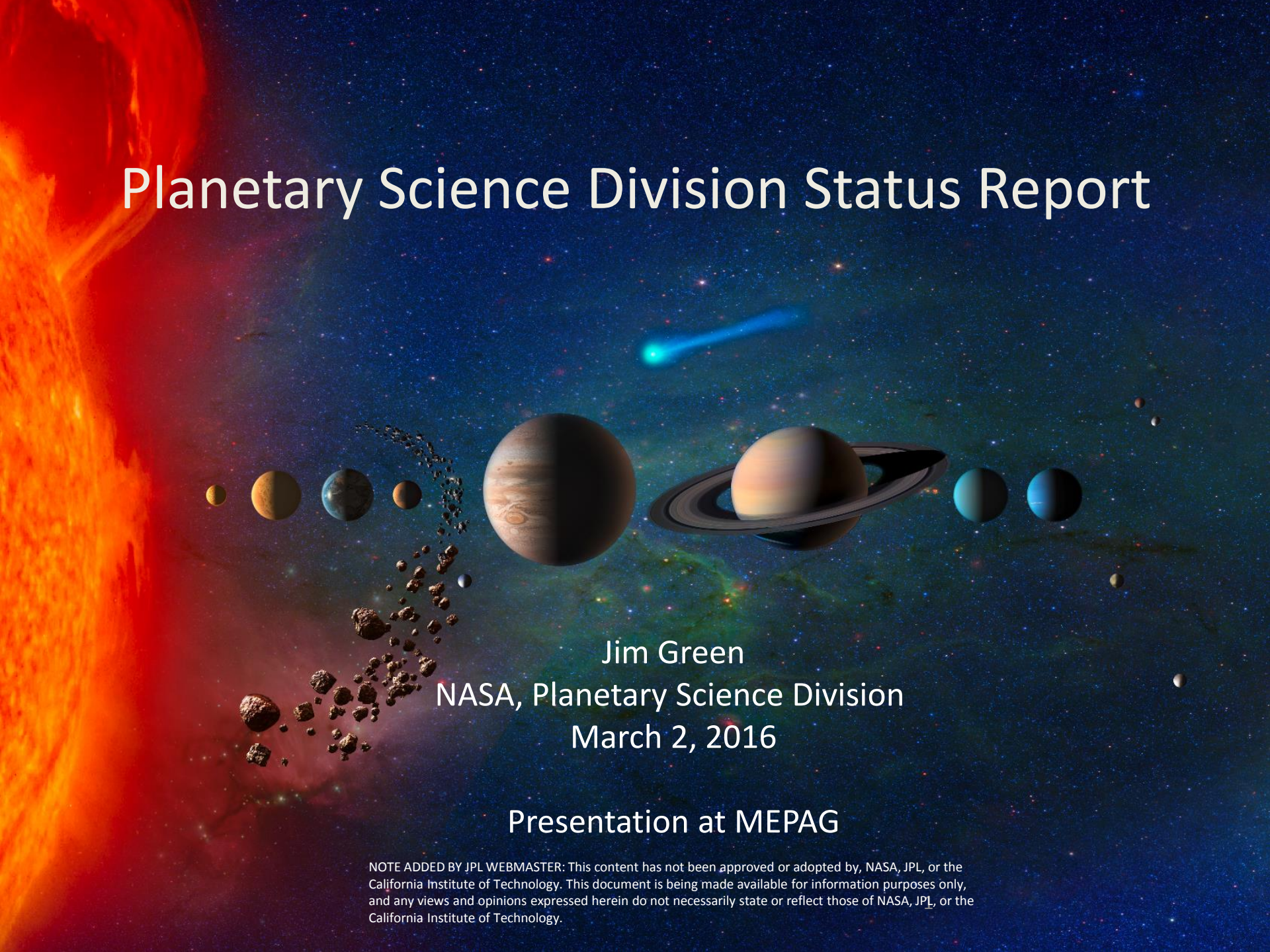
Planetary Science Division Status Report



Jim Green
NASA, Planetary Science Division
March 2, 2016

Presentation at MEPAG

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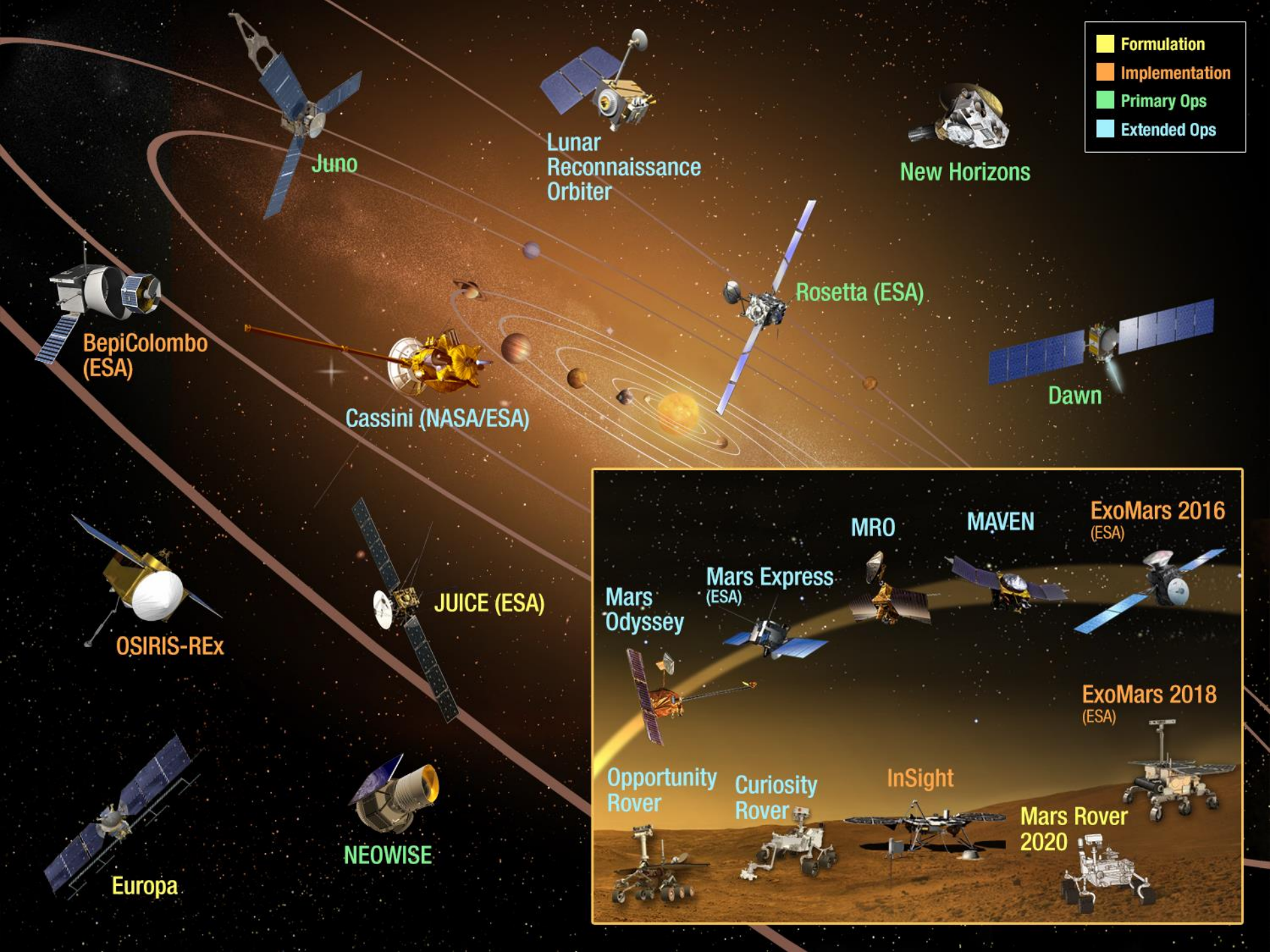
Outline

- Mission Overview
- FY 2016 Appropriation
- FY 2017 President's Budget
- Discovery & New Frontiers Programs
- New Cubesat Selections


Formulation
Implementation
Primary Ops
Extended Ops
Juno
Lunar Reconnaissance Orbiter
New Horizons
BepiColombo (ESA)
Rosetta (ESA)
Cassini (NASA/ESA)
Dawn
OSIRIS-REx
JUICE (ESA)
Europa
NEOWISE
MRO
MAVEN
ExoMars 2016 (ESA)
Mars Express (ESA)
Mars Odyssey
ExoMars 2018 (ESA)
Opportunity Rover
Curiosity Rover
InSight
Mars Rover 2020

Planetary Science Missions Events

2014

July – *Mars 2020* Rover instrument selection announcement

*** Completed**

August 6 – 2nd Year Anniversary of *Curiosity* Landing on Mars

September 21 – *MAVEN* inserted in Mars orbit

October 19 – Comet Siding Spring encountered Mars

September – *Curiosity* arrives at Mt. Sharp

November 12 – ESA's *Rosetta* mission lands on Comet Churyumov–Gerasimenko

December 2/3 – Launch of *Hayabusa-2* to asteroid 1999 JU_3

2015

March 6 – *Dawn* inserted into orbit around dwarf planet Ceres

April 30 – *MESSENGER* spacecraft impacted Mercury

May 26 – Europa instrument Step 1 selection

July 14 – *New Horizons* flies through the Pluto system

September – Discovery 2014 Step 1 selection

December 6 – *Akatsuki* inserted into orbit around Venus

2016

March – Launch of ESA's *ExoMars Trace Gas Orbiter (*Launch of NASA's *InSight postponed)*

July 4 – *Juno* inserted in Jupiter orbit

September – Launch of Asteroid mission *OSIRIS – REx* to asteroid Bennu

September – *Cassini* begins plane change maneuver for the "Grand Finale"

Late 2016 – Discovery 2014 Step 2 selection

FY16 Appropriation supports a robust Planetary Science program

Planetary Science $270M above the request, at $1.63B

- $277M for Planetary Science Research
- $189M for Discovery (+$33M), including full funding for LRO
- $259M for New Frontiers
- $448M for Mars (+$36M), including full funding for Opportunity
- $197M for Technology (+$55M)
  - Includes $25M for icy satellites surface technology
- $261M for Outer Planets (+$145M) with direction
  - Directs that the Europa mission be launched on an SLS in 2022 and that a lander be included ($175M)
- Direction to continue to fund AIDA/DART joint study with ESA
- Direction to establish a new Ocean Worlds program *with a primary goal to discover extant life on another world* using a mix of Discovery, New Frontiers, and flagship class missions

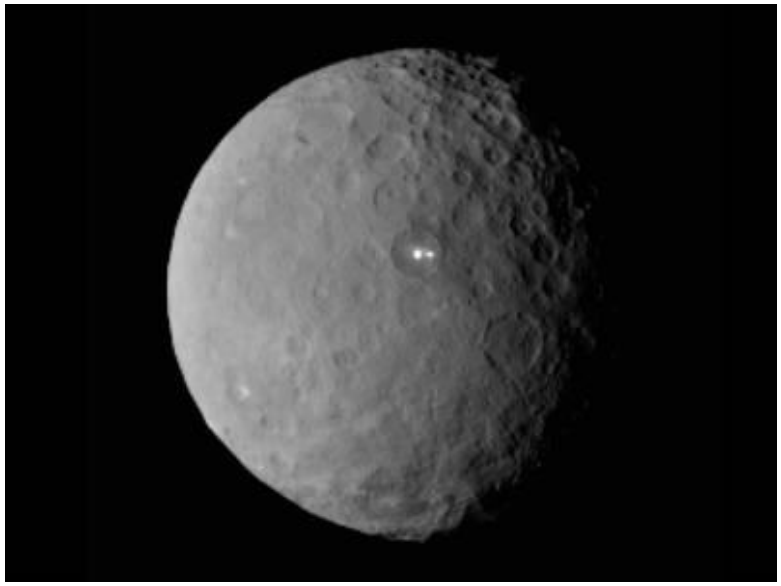
President’s FY17 Budget

Planetary Science

Outyears are notional

($M)	2016	2017	2018	2019	2020	2021
Planetary Science	$1,631	$1,519	$1,440	$1,520	$1,576	$1,626

- Continues development of the Mars 2020 mission.
- Funds continued formulation of a mission to Jupiter's moon, Europa.
- Continues work on the JUICE instrument in collaboration with the European Space Agency mission to Jupiter.



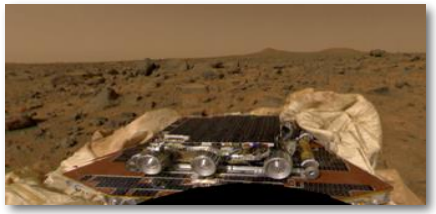
- Initiates studies for the next New Frontiers Mission and continues operations of Juno and New Horizons.
- Operates 13 Planetary missions including MAVEN, Mars Curiosity, Opportunity, Odyssey, Mars Express, and Cassini (Saturn).
- Increases support for technology development to accelerate future power systems.
- Increases support for Research and Analysis.

Discovery & New Frontiers

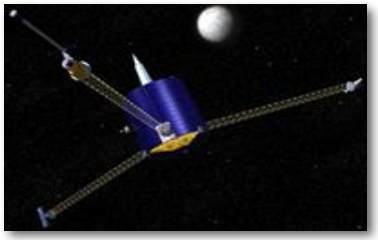
Discovery Program

Completed

Mars evolution:
Mars Pathfinder (1996-1997)

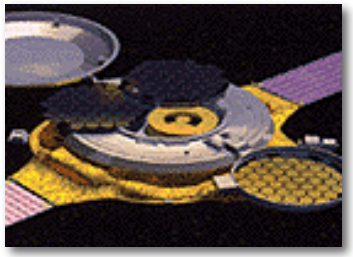


Lunar formation:
Lunar Prospector (1998-1999)



NEO characteristics:
NEAR (1996-1999)

Solar wind sampling:
Genesis (2001-2004)

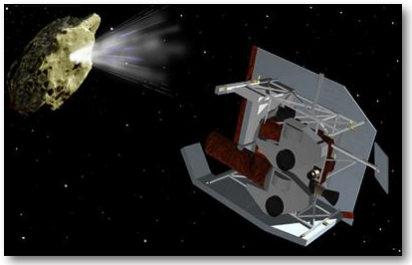


Completed

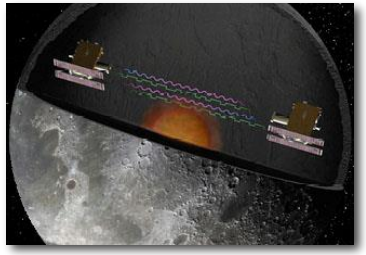
Comet diversity:
CONTOUR (2002)

Nature of dust/coma:
Stardust (1999-2011)

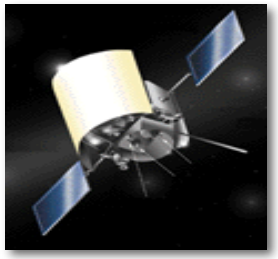
Comet internal structure:
Deep Impact (2005-2012)



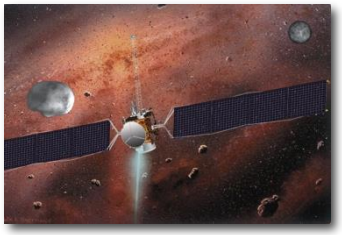
Lunar Internal Structure
GRAIL (2011-2012)



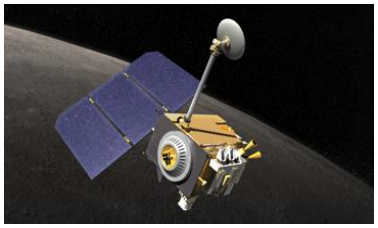
Mercury environment:
MESSENGER (2004-*2015*)



Main-belt asteroids:
Dawn (2007-*2016*)



Lunar surface:
LRO (2009-*TBD*)



ESA/Mercury Surface:
Strofio (*2017-TBD*)

Mars Interior:
InSight (*TBD*)

Status of Discovery Program

Discovery 2014 – Selections announced September 30

- About 3-year mission cadence for future opportunities

Missions in Development

- *InSight*: Missed March 2016 launch window
- Strofio: Delivered to SERENA Suite (ASI) for BepiColombo

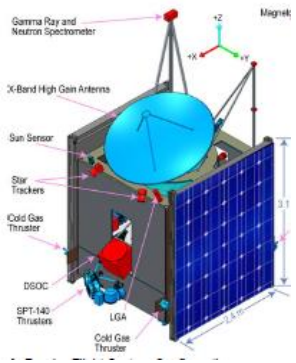
Missions in Operation

- *Dawn*: Science observation now in Low Altitude Mapping Orbit

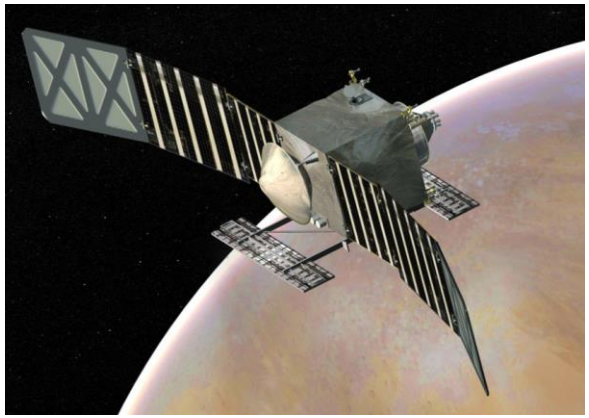
Missions in Extended Operations

- *LRO*: In stable elliptical orbit, passing low over the lunar south pole

Discovery Selections 2014

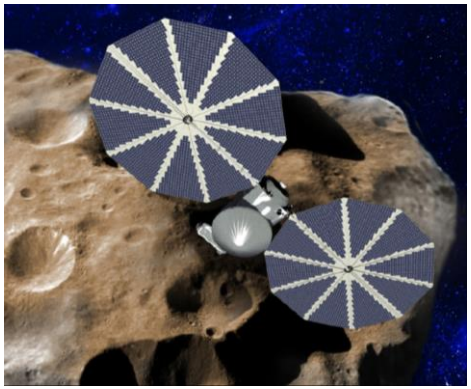


Psyche: Journey to a Metal World
PI: Linda Elkins-Tanton, ASU
Deep-Space Optical Comm (DSOC)

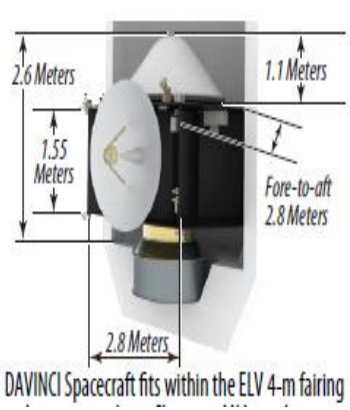


VERITAS: Venus Emissivity, Radio Science, InSAR, Topography, And Spectroscopy
PI: Suzanne Smrekar, JPL
Deep-Space Optical Comm (DSOC)

NEOCam:
Near-Earth Object Camera
PI: Amy Mainzer, JPL
Deep-Space Optical Comm (DSOC)



Lucy: Surveying the Diversity of Trojan Asteroids
PI: Harold Levison, Southwest Research Institute (SwRI)
Advanced Solar Arrays



DAVINCI: Deep Atmosphere Venus Investigations of Noble gases, Chemistry, and Imaging
PI: Lori Glaze, GSFC

New Frontiers Program

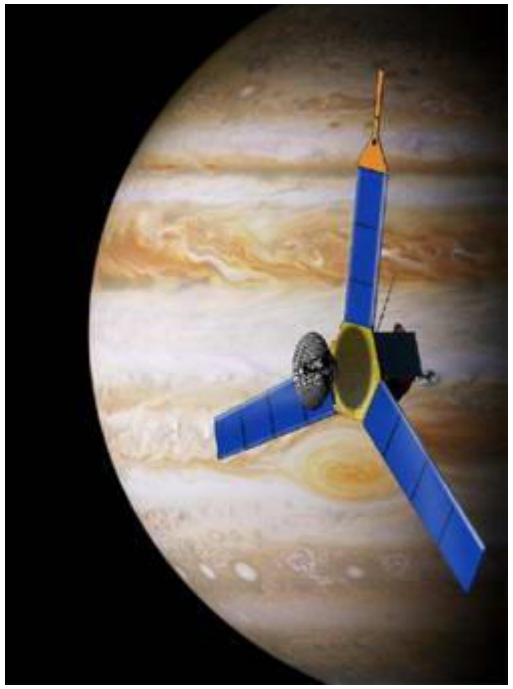
1st NF mission
New Horizons:

Pluto-Kuiper Belt

Launched January 2006
Flyby July 14, 2015
PI: Alan Stern (SwRI-CO)

2nd NF mission
Juno:

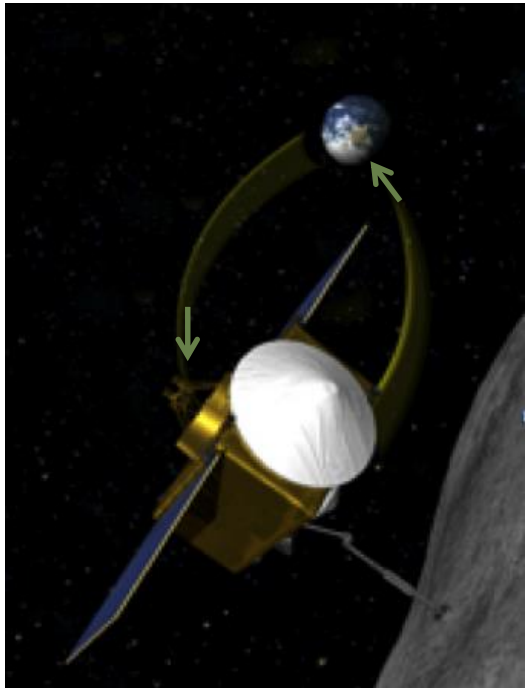
Jupiter Polar Orbiter



Launched August 2011
Arrives July 4, 2016
PI: Scott Bolton (SwRI-TX)

3rd NF mission
OSIRIS-REx:

Asteroid Sample Return



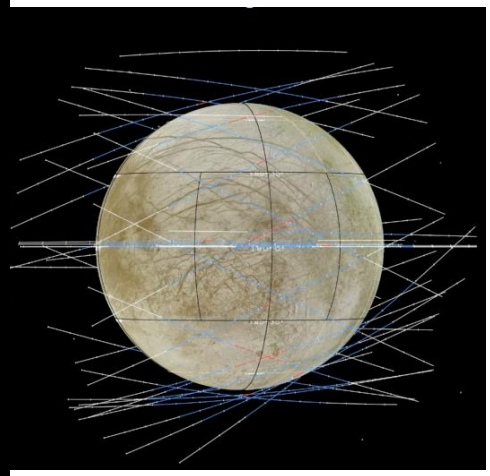
Launch window: Sept. 8, 2016
PI: Dante Lauretta (UA)

Next New Frontiers Program AO

- Community Announcement Regarding New Frontiers Program January 2016
- Draft to be released by end of Fiscal Year 2016 (September)
- Investigations are limited to the following mission themes (listed without priority):
  - Comet Surface Sample Return
  - Lunar South Pole-Aitken Basin Sample Return
  - Ocean Worlds (Titan, Enceladus)
  - Saturn Probe
  - Trojan Tour and Rendezvous
  - Venus In Situ Explorer

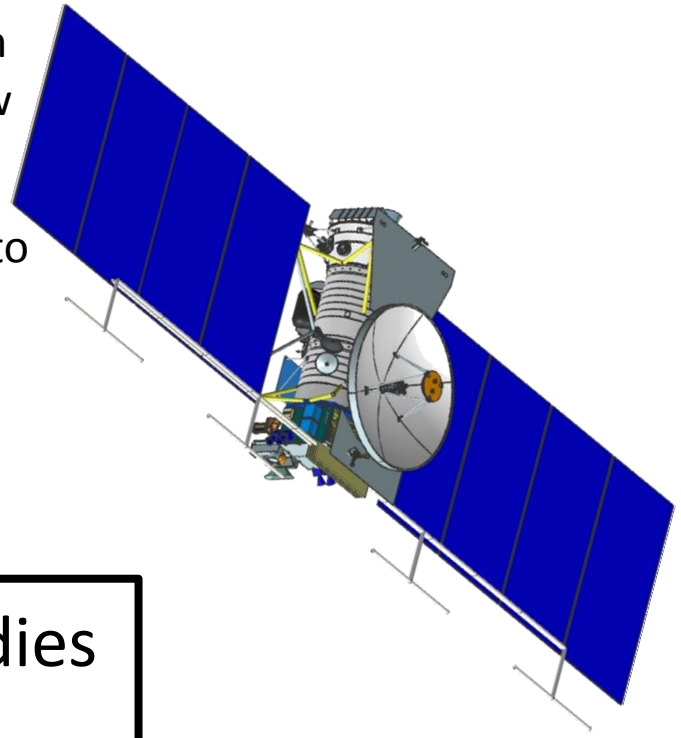
Europa Mission

Europa Multi-Flyby Mission Concept Overview



Science	
Objective	**Description**
Ice Shell & Ocean	Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange
Composition	Understand the habitability of Europa's ocean through composition and chemistry.
Geology	Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.
Recon	Characterize scientifically compelling sites, and hazards for a potential future landed mission to Europa

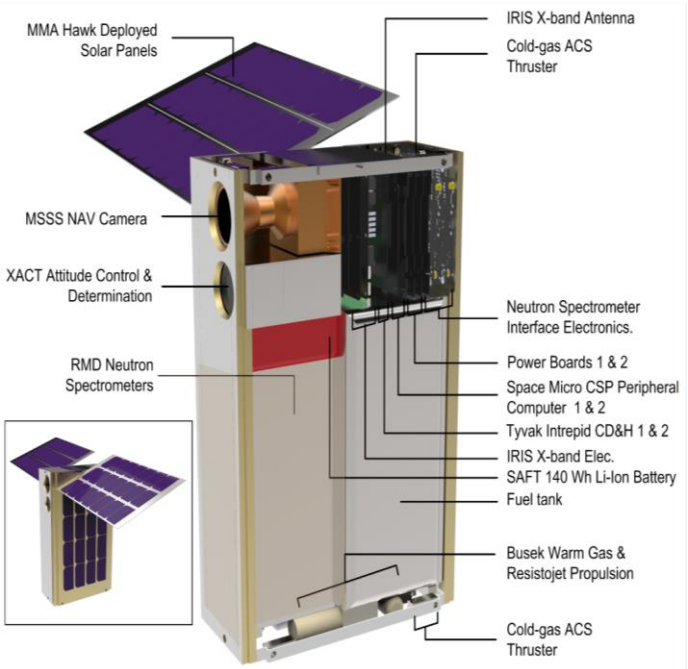
- Conduct 45 low altitude flybys with lowest 25 km (less than the ice crust) and a vast majority below 100 km to obtain global regional coverage
- Traded enormous amounts of fuel used to get into Europa orbit for shielding (lower total dose)
- Simpler operations strategy
- No need for real time down link



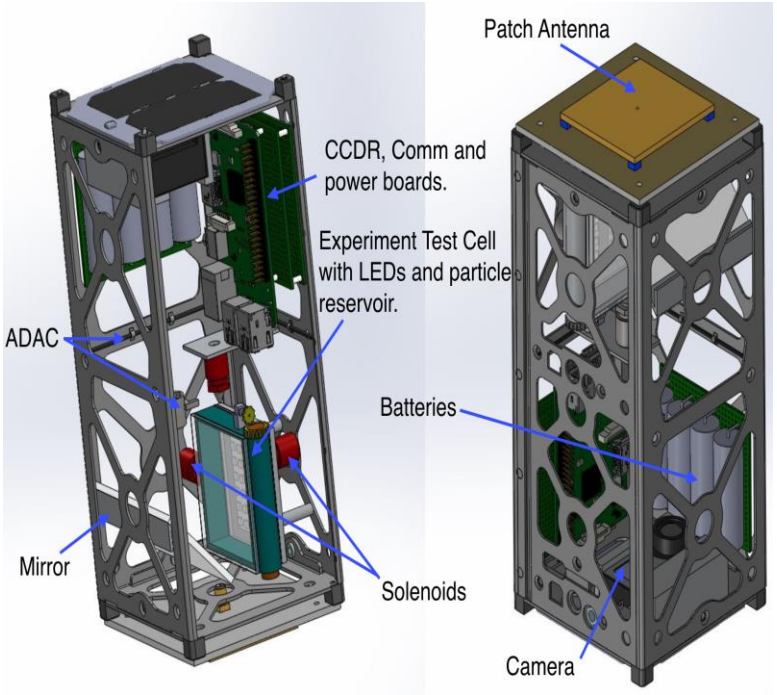
Lander Concept Studies Are Continuing

SIMPLEx Cubesats Selections
Full missions (2)
and
Approved for 1 year Tech Development (3)

Small Innovative Missions for Planetary Exploration (SIMPLEx-2014) – New Awards in FY15



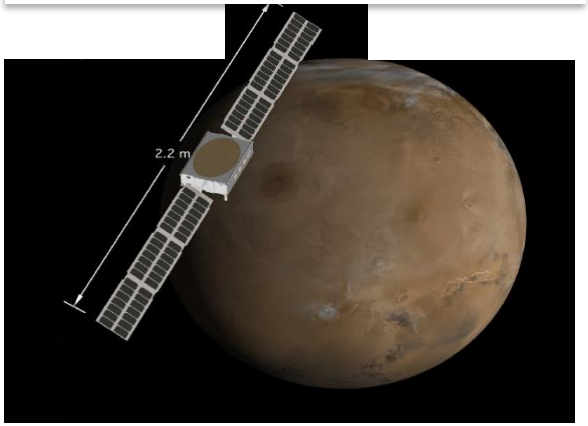
Lunar Polar Hydrogen Mapper (LunaH-Map)
PI: Craig Hardgrove
ASU School of Earth and Space Exploration



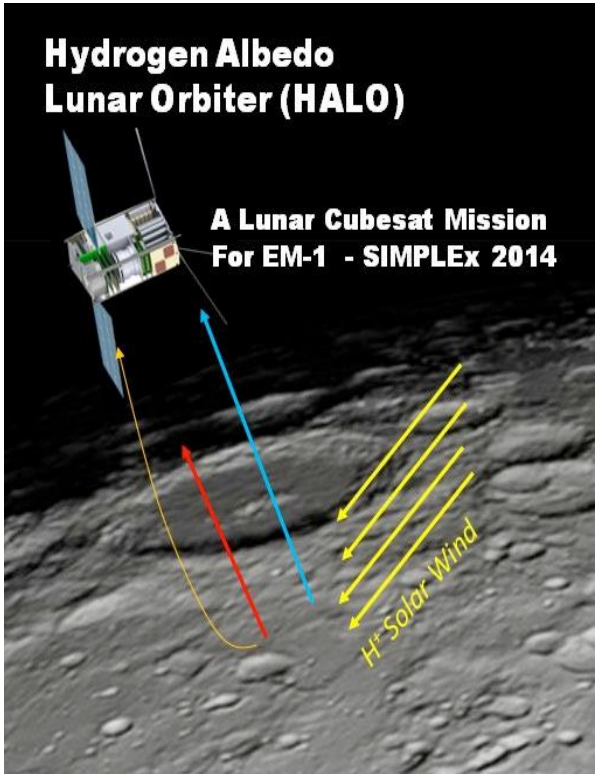
CubeSat Particle Aggregation and Collision Experiment (Q-PACE)
PI: Josh Colwel
University of Central Florida

Simplex Cubesats

Approved for Tech Development (1 year) Study ONLY



Mars Micro Orbiter
PI: Michael Malin
Malin Space Science Systems



Hydrogen Albedo Lunar Orbiter (HALO)
PI: Michael Collier,
NASA GSFC

Diminutive Asteroid Visitor using Ion Drive (DAVID)
PI: Geoffrey Landis
NASA Glenn Research Center

Questions?

New Frontiers 4

- Why was the Ocean Worlds mission theme added to NF4?
  1. NOSSE Report: As a strategic program NF should be "adaptable to new discoveries"
  2. Consistent with the V&V Planetary Decadal
  3. Strong science case for Enceladus and Titan
  4. Congressional FY16 Approps: Response is required
- Next Steps:
  - Present that decision and rationale to PSS for feedback (considering AG input)
  - Present that decision and rationale to CAPS for feedback – midterm charge will also address how to accommodate recent discoveries
  - Community can also comment via the draft AO process

Planetary Defense Coordination Office (PDCO)

Hosted by the Planetary Science Division PDCO is responsible for:

- Oversight of potentially hazardous objects (PHOs):
  - Ensure early detection
  - Characterize PHOs of size large enough to affect Earth's surface
  - Provide warning of potential impact effects if not deflected or mitigated
  - Provide timely and accurate communications about PHOs and any potential impact
- Lead research into potential asteroid deflection and impact mitigation technologies and techniques
- Provide lead coordination role in U.S. Gov't planning for response to an actual impact threat (*e.g.,* planetary science and deep space mission expertise for Federal Emergency Response Team)